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SOARING WITHOUT RISING CURRENTS.

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## SOARING WITHOUT RISING CURRENTS.\*

By Edward P. Warner.

The more difficult and more important stages of the problem of soaring flight, those which relate to the maintenance of altitude and the indefinite continuation of flight without dependence on rising currents from any source whatever, have as yet hardly been touched. The future of soaring, in so far as there is any real future of practical use, lies in those stages, however, for it is obviously impossible always to carry an ascending current about with one.

It is possible to say at once, with perfect definiteness, that it is not now and will not at any time in the future become possible to soar without power in still or steadily moving air. That would be perpetual motion, nothing more or less, and if it were accomplished it would become necessary to rewrite the fundamental rules on which all knowledge of mechanics is based, rules confirmed and reinforced by centuries of study and experiment.

Between the manifestly impossible feat just cited and the making of flights of long duration by the utilization of ascending currents, the latter already many times accomplished, there lies a wide area of debatable ground, not yet conquered in practice but at least shown by theory to be open to invasion. The most notable sections of that doubtful area relate to possible soaring in winds of rapidly fluctuating strength, the theory of which was first expounded by Langley in 1896 and has been further analyzed by many

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European writers since Langley's time, and to soaring in winds of varying inclination.

The schemes for the use of fluctuating wind-speeds for soaring may be divided into two classes, their assignment to one or the other depending on whether the response to variations is automatic and inherent in the glider, or whether it must be produced by the pilot. On the whole, the first class seem the more hopeful, as the wind changes so suddenly and so irregularly that the most skillful pilot can hardly be expected to keep up with the alterations and to operate his controls in such a way as to take advantage of them unless he can be endowed with some sort of magic spectacles enabling him to see the approaching changes before they actually arrive, as a sailor can see a squall approaching across the water. If the wind speed would have the kindness to vary, according to some definite formula or some smooth curve of change, soaring would be easy, but unfortunately the ideal gust forms on which theories of methods of piloting are built up, do not correspond to anything existing in reality.

If it be assumed that the compensation for atmospheric changes should be automatic, there are several possible directions of experiment. The three which are most obvious of them all having been tried at least in a small way, are the use of wings with flexible trailing edges, the tilting of the wings as a whole to change the angle of attack when the pressure changes, and the swinging of the wings forward and backward. Trailing edges have been made flexible in varying degrees on certain airplanes and gliders for a number of

years, and it is interesting to observe that one of the three airplanes which have made the longest glides, the Hanover monoplane of Hentzen, is remarkable for the flexibility of the rear parts of its wing-tips. In the case of the Hanover glider, the angle between the gliding path and the horizontal was so small and the glide was so flat, even when there seemed to be no rising current to help out, that it was difficult to account for on any score except the automatic use of variations in velocity changing the form of the flexible wing as it was struck by the air with varying force.

The other two schemes have less record of definite record-making achievement than has the flexible trailing edge. Airplanes with variable angle of attack, the wings tilting as a whole, have often come to grief because of the difference between their controls and those of an airplane, the ordinary airplane pilot finding it difficult to accommodate himself to their operation. In fact, the most successful glides with variable-angle soaring airplanes have been made by Mr. Harth, a German pilot who learned to fly on gliders, never having had any experience on powered airplanes. Harth at one time held the world's record for duration with a flight of 31 minutes and 40 seconds.

#### Swinging Wings.

The swinging-wing arrangement is being studied and tried by a number of experimenters in Germany, but no very remarkable results have as yet been announced. From a mechanical point of view

it is, of course, difficult to swing the wings as a whole without interfering with their strength, much more difficult than to make the ribs flexible near the trailing edge, and the development of the swinging-wing type has been retarded by the severity of the mechanical problem.

Turning from the automatic soaring devices to those under the control of the pilot, the latter depend in most cases on systems of piloting which are applicable to any ordinary machine responding quickly and positively to its controls. The most notable of such schemes calls for the following of either a circular or an S-shaped course, the glider being turned against the wind as the wind-speed rises and away from the wind when the speed is dying down. This would of course be rather a slow and circuitous method of getting from point to point equivalent to the "tacking" of a sailing vessel moving against the wind, but it would at least be a possible one if the wind-changes were steady and regularly spaced so that the pilot might foresee their coming. As already noted, however, they unfortunately are not of any such simple nature.

Soaring is theoretically possible not only with a wind varying in velocity but also with one varying in direction. In fact, it has been shown in a wind tunnel that if a wing is supported in a wind stream which is continually changing its inclination, varying between a few degrees above the horizontal and a few degrees below, the wing will tend to advance upstream instead of being blown along in the wind direction. It would therefore be possible

to soar indefinitely with a glider of the usual type wherever such conditions of rapidity and continuously varying direction exist, but it seems rather doubtful if they are anywhere common enough so that the pilot of an engineless airplane might count on finding them when he wanted them.

In summary, the present outlook for soaring without rising currents cannot be said to be hopeful. The best chance of success lies in the direction of the utilization of the energy stored in the air when the wind speed is constantly and rapidly varying. Further research on the extent and nature of such variations on atmospheric structure generally would be very profitable, and will undoubtedly be undertaken in increasing numbers.



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